Dusty Plasma Experiments Using an Electrodynamic Balance

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Knowledge of the formation, distribution, physical, chemical and optical characteristics of interstellar, interplanetary, and planetary dust grains provide valuable information about many issues dealing with the origin and formation of the solar system bodies, interplanetary and interstellar environments as well as various industrial processes. Understanding the microphysics of individual grains and their interaction with the surrounding environment is key to properly model various conditions and interpret existing data. The theory and models of individual dust grains are well developed for environments that vary from dense planetary atmospheres to dusty plasmas to diffuse environments such as interplanetary space. However, experimental investigations of individual dust grains in equilibrium are less common, perhaps due to the difficulty of these experiments. Laboratory measurements of dust grains have primarily measured ensemble properties or transient properties of single grains.

A technique developed in the 1950's for ion spectroscopy, known as a quadrupole trap or 'Paul Trap', has recently been used to investigate single micron-sized dust grains. This scaled ion trap called an electrodynamic balance has been used for atmospheric aerosol research. A description of this technique is provided. Recent results from experiments to investigate the equilibrium potential of dust grains exposed to far ultraviolet light or to an electron or ion beam are presented. This laboratory technique lends itself to many applications that relate to planetary atmospheres, heliospheric environments, pre-stellar and pre-planetary conditions, and industrial settings. Several planned experimental approaches are presented. Potential experiments to investigate the interaction of multiple dust grains using an electrodynamic balance are proposed.